Reg No 6637. 3 vers copies
K121

Farmers Bulletin 1237
United States Department of Agriculture

PINEAPPLE CULTURE IN FLORIDA

THIS BULLETIN discusses the history of pineapple growing in Florida, the usual methods of culture, the causes for the recent decline of the industry, and the most promising methods for its restoration.

This once thriving industry has rapidly declined in recent years. Most of the fields have been abandoned and pineapple growing in Florida is now threatened with extinction. The chief causes are the depletion of soil humus and fertility through constant cultivation and exposure to the tropical sun, the growing prevalence of wilt due to attacks of nematodes, and failure to use healthy, vigorous slips in new plantings.

As a practical method of restoring abandoned fields, it is recommended that Natal grass be sown and allowed to grow on the impoverished soil for two years or longer. This practically starves out the nematodes, as Natal grass is immune, or nearly so, to them, and at the same time adds the essential humus to the soil. Carefully selected and vigorous slips should then be planted. Whenever pineapples begin to show a decrease in production the land should again be rotated to Natal grass.

By the use of the methods suggested, which are based upon experimental planting made by the Bu reau of Plant Industry, it is believed that pineapple growing eventually can be reestablished, not only in Florida, but in other sections where similar conditions exist.

Contribution from the Bureau of Plant Industry
WM. A. TAYLOR, Chief

Washington, D. C. Issued November, 1921

PINEAPPLE CULTURE IN FLORIDA.[1]

By E. D. Vosburg, formerly *Scientific Assistant, Office of Horticultural and Pomological Investigations*, and J. R. Winston, *Pathologist, Office of Fruit-Disease Investigations.*

CONTENTS.

	Page.		Page.
Geographic distribution of pineapple culture	3	Harvesting and marketing	21
History of the Florida pineapple industry	3	Yields and profits	24
Selecting a locality and site for the pineapple plantation	5	Bearing life of plantations	25
Pineapple varieties for Florida	9	Pests and diseases	26
Propagation	10	Depletion of soil humus	31
Management of pineapple plantations	16	Restoration of the pineapple industry	32
		A practical method of restoring abandoned plantations	33
		Conclusions	35

GEOGRAPHIC DISTRIBUTION OF PINEAPPLE CULTURE.

THE PINEAPPLE, universally considered one of the finest of all fruits, is widely cultivated throughout the tropical regions of the world. Large quantities of the fresh fruit are annually imported into the United States from the West Indies (including Porto Rico), and from the Hawaiian Islands still larger shipments of the canned article are received.

A native of tropical South America, the pineapple is so easily injured by cold that its culture in the United States is restricted to the regions of southern Florida most nearly frost free. Small plantings have been started from time to time in California and in southeastern Texas, but these have been abandoned on account of adverse climatic or other conditions.

HISTORY OF THE FLORIDA PINEAPPLE INDUSTRY.

The earliest recorded successful planting of pineapples in Florida was made in 1860, when Benjamin Baker, of Key West, obtained a number of slips from Havana and started a small experimental patch on Plantation Key.[2] The venture was so successful and the

[1] The writers are indebted to C. D. Sherbakoff, pathologist, Florida Agricultural Experiment Station; R. L. Goodwin, A. W. Hoofnagle, and T. C. Heoflich, Fort Pierce, Fla.; C. Dunscombe, Stuart, Fla.; T. V. Moore, Miami, Fla.; and other pineapple growers and investigators for valuable suggestions and assistance.

[2] Report on the condition of tropical and semitropical fruits in the United States in 1887. U. S. Dept. Agr., Div. Pomol. Bul. 1, 149 p., 3 col. pl. 1888.

profits realized were so excellent that a rapid growth of the industry on the keys resulted. (Fig. 1, *B*.) The shallow soils of the keys soon became exhausted, and most of the plantations there were abandoned. In the meanwhile the industry had spread to other parts of Florida where pineapple culture met with varying success. A number of plantings under sheds were made in Lake, Orange, Volusia, and other interior counties, but with few exceptions these were soon abandoned. By 1890 the industry had become centralized in the famous east-coast pineapple belt, extending from the vicinity of Fort Pierce southward to Miami (fig. 1, *A*).

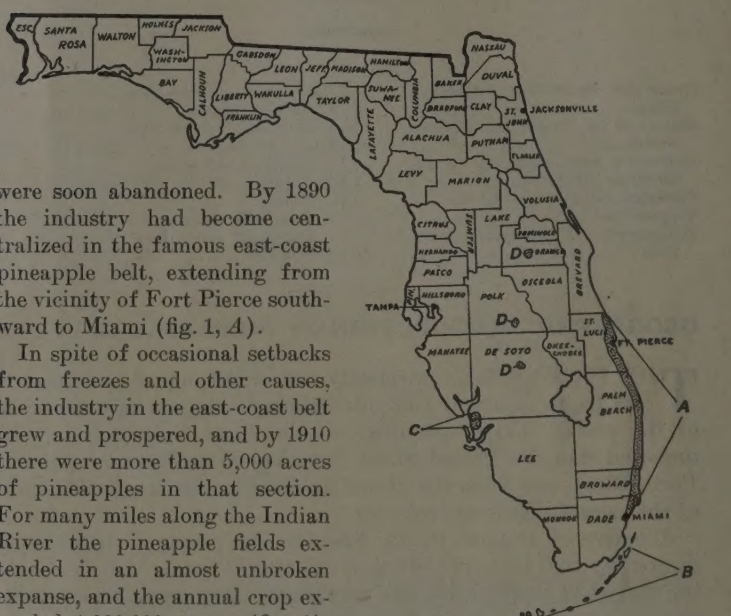

FIG. 1.—Dotted areas indicate the principal pineapple-growing sections: *A*, East-coast belt; *B*, keys section; *C*, Punta Gorda section; *D*, old region of scattered plantings under sheds.

In spite of occasional setbacks from freezes and other causes, the industry in the east-coast belt grew and prospered, and by 1910 there were more than 5,000 acres of pineapples in that section. For many miles along the Indian River the pineapple fields extended in an almost unbroken expanse, and the annual crop exceeded 1,000,000 crates (fig. 2). At about that time, however, serious crop shortages began to occur in some of the older plantings, where the plants commenced to show loss in vigor and decreasing yields. This decline became more and more prevalent, until by 1917 many of the fields had been permanently abandoned or neglected (fig. 3). A heavy freeze which swept over the State in February, 1917, and a second freeze in the fall of that year were final blows to many growers. In 1920 there were only a few hundred acres of bearing pineapples in Florida. But few new plantings had been made since the freeze of 1917, owing to the scarcity of slips and to the belief of the growers that the suitable pineapple soils were exhausted.

Near Punta Gorda, on the western coast of the State, about 60 acres of pineapples were grown with shed protection in 1915 (fig. 1, *C*). Fruit of choice quality was produced, and the industry there was considered quite promising. As on the east coast, however, these plantings have largely died out during the past few years, and in 1920 only 2 or 3 acres remained (fig. 4).

The failure of the pineapple industry of Florida is a particularly serious matter to the farmers of these localities, as much of the land on which this fruit has been grown is too light and sandy for the profitable production of other crops. The demand for reliable information regarding the profitable restoration of the abandoned fields is therefore urgent.

FIG. 2.—Part of the east-coast pineapple belt, near Jensen, Fla., showing the elevation of the land above the surrounding country, with marshes at the left and the Indian River at the right.

SELECTING A LOCALITY AND SITE FOR THE PINEAPPLE PLANTATION.

SELECTING A GENERAL LOCALITY.

As pineapples are injured by temperatures lower than 30° F., a locality for their culture should be selected which is practically free from severe freezes. Nearly all plantings in Florida have been made in the southern portion of the State. It should be understood, however, that though general climatic conditions become more tropical as one proceeds southward, latitude alone does not determine the danger from freezes. Damage from cold is often greater in southern localities than in latitudes farther north, and the topography and

surroundings of a locality influence its liability to freezes and its suitability for tropical fruit culture. The effects of local climatic conditions are illustrated in the leading pineapple sections of Florida.

The earliest plantings were made on the coastal islands, or keys (fig. 1, *B*), in the extreme southern part of the State, which are surrounded and protected by large bodies of salt water. The famous east-coast pineapple belt (fig. 1, *A*) consists of a narrow ridge, an ancient sand dune, 1 to 3 miles wide and about 150 miles long, which is elevated some 25 to 50 feet above the surrounding country. It is bounded on the east by the waters of the Indian River and the Atlantic Ocean and on the west by marshes known locally as "savannahs" (see figs. 2 and 24). The elevation of this ridge above the sur-

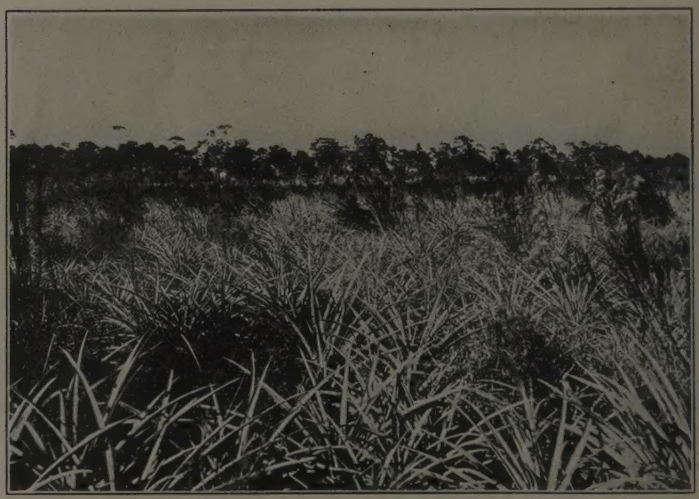

FIG. 3.—An abandoned pineapple field.

rounding country adds greatly to its freedom from frost, as the cold air drains to the lower levels. The large bodies of water on either side of the ridge also furnish further protection from cold.

SELECTING A PARTICULAR SITE.

After a favorable general locality has been decided on, consideration should be given to the selection of a desirable site within that region. The choice must be made with great care, as very frequently desirable and unsuitable sites are found in close proximity. Careful consideration should be given to the questions of local air drainage and water protection and their influence on potential damage from cold. The factor of roads should also be taken into account, as pine-

apples are injured by long hauls over rough roads, and, besides, such hauls are expensive. A field should be selected, therefore, as near as possible to a good shipping point (fig. 5). Among other points which should be considered in selecting a site are community advantages, an adequate supply of labor, and marketing facilities.

Many of the conditions for successful pineapple growing will be unfamiliar to growers who may have been successful with other fruits. The mistake of choosing an unsuitable site for a pineapple plantation, as in the case of other kinds of fruit growing, is likely to prove extremely costly and is usually without remedy. The newcomer, especially when his capital is limited, should proceed with great caution and purchase land only after thorough investigation and after consultation with successful growers.

FIG. 4.—An abandoned shed pineapple plantation.

SOILS FOR PINEAPPLES.

Pineapples require an open, thoroughly drained soil. Nearly all of the Florida plantings have been made on light sandy soils, too low in fertility for most crops but adapted for pineapples when properly fertilized and supplied with humus. The maintenance of a sufficient supply of humus in pineapple growing, as in the culture of other crops, is essential in order to increase the beneficial activity of soil organisms, to promote the general fertility of the soil, and to improve its physical condition. Most Florida pineapple soils in their original state are poorly supplied with humus, and one of the essential measures that must be taken in building up the Florida pineapple industry, as will be shown later in considering humus depletion, is that of maintaining and increasing the humus supply.

Most of the fields of the east-coast belt have been planted on scrub-pine land which bears an original growth of scrub-pine [3] trees. The soil of this type is a white sand underlain at a depth of 5 feet or more with a subsoil of yellow sand. A somewhat more limited soil type is that known as "hickory scrub," which supports a native growth of hickories, oaks, and other hardwood trees. It is underlain at a depth of 5 to 10 inches with the same yellow sand subsoil found at a much greater depth in the scrub-pine land. The soil of the "hickory scrub" land is somewhat finer in texture, richer in humus, and more retentive of fertility than the scrub-pine land. It is the soil

FIG. 5.—A packing house conveniently located adjacent to a railroad track.

type preferred by most experienced Florida growers. The hammock type of land (fig. 6) in a virgin state is characterized by a growth of cabbage palmettos and live oaks. This type is the richest in fertility and humus of any of the soils commonly used for pineapples. It is also well adapted for vegetables and other crops, but is only found in small tracts in the pineapple-growing sections. The high pineland is considered satisfactory for pineapples, but is found only to a very limited extent in Florida regions where climatic conditions permit the growing of pineapples in the open. Flatwoods pineland, found particularly in the vicinity of Miami and Punta Gorda, is also satisfactory when provided with natural or artificial drainage (fig. 7).

[3] *Pinus clausa.*

PINEAPPLE VARIETIES FOR FLORIDA.

A large number of pineapple varieties have been introduced into Florida from time to time, many of them being still found in home gardens and experimental plantings. Only two or three varieties are grown on a commercial scale.

The Spanish (*Red Spanish*) variety, spoken of as the "common" pineapple, is by far the most widely cultivated, constituting more than 90 per cent of the total plantings (fig. 8). The plants are hardier than those of the other common varieties and easier to grow. They are easily propagated from slips, which are abundantly produced (fig. 9). The fruits of this variety are of medium size and possess excellent shipping quality when carefully handled, but their

FIG. 6.—Hammock land on the border of the Indian River.

dessert quality, while good, is inferior to that of other varieties grown.

The only other pineapple variety grown in Florida to any important extent is the Cayenne (*Smooth Cayenne*). The plants of this variety are large, with broad leaves, free from spines. The fruits are larger and have higher dessert quality, but are more tender, more easily injured, and require much more care in handling and shipping than those of the Spanish variety. The Cayenne is propagated chiefly from suckers, as few slips are produced. The scarcity of slips is a serious drawback when rapid propagation is desired, as but one or two suckers can be taken from a plant. The Cayenne is the principal variety canned in Hawaii.

The Abachi (*Abakka*) variety is grown to a very limited extent in one or two localities. The fruits are of large size and of excellent

dessert quality (fig. 10), but they are tender and must be carefully handled in harvesting and shipping.

A serious fault of the Abachi variety is that the slips are often attached so closely to the base of the fruit that it is difficult to separate them without injury to the fruit.

For the average grower in Florida the hardy and easily grown Spanish is probably the best variety to plant. The grower who desires to develop a special market for fancy fruit and who is prepared to give his crop the most skillful and painstaking attention will usually prefer the Cayenne or the Abachi variety.

FIG. 7.—A pineapple plantation on flatwoods pineland.

PROPAGATION.

SUCKERS, RATOONS, AND SLIPS.

After fruiting, the central portion of the plant gradually dies back toward the base. Before the fruit is mature, however, suckers begin to develop in the axils of the leaves above ground and other suckers, called ratoons, also develop from points along the stem below the surface of the ground. These ratoons take root directly in the soil, while the suckers which develop from the axils of the leaves are nourished first through the base of the parent plant and later by aerial root systems which eventually take root in the ground. The plant growths from buds on the fruit stalk near the base of the fruit are known as "slips," while the tuftlike growth at the top of

the fruit is called a "crown." Slips appearing at the apex of the fruit just below the crown are called "crown slips" (fig. 11).

The pineapple occasionally produces seeds. These, however, do not reproduce the variety. They are rarely used, except for experimental purposes. Several years are required to produce a mature plant from a seed.

Propagation is usually accomplished by means of slips or suckers, although crowns and other vegetative parts of the plants are sometimes used. The Spanish variety is commonly propagated from slips, which are produced at the average rate of five or six to the plant. The Cayenne variety produces an average of less than one

FIG. 8.—A field of Spanish (*Red Spanish*) pineapples on flatwoods land.

to the plant and is commonly propagated both from slips and suckers. The Abachi variety is usually propagated by means of slips, which are abundantly produced.

The ratoons are generally left in place to perpetuate the plantation. As they develop they take the place of the former fruit-bearing stalk. The suckers, unless removed, normally take root and also form new fruiting plants. After they have produced fruit they in turn give way to other ratoons or basal suckers. The number of ratoons a plant may develop varies, as does the number of slips and suckers. Two ratoons to each plant are desirable for perpetuating a plantation. If surplus ratoons develop, they may be removed and used, as are slips and suckers, for other plantings.

COLLECTING AND PREPARING SUCKERS AND SLIPS.

The same methods are used in the collection and preparation of both suckers and slips. Although planting may be successful at any

FIG. 9.—The Spanish (*Red Spanish*) fruit and slips.

season, it is usually done in August and September. Most growers prefer to set their slips before the middle of September, in order to

secure the advantages of the summer rainy season. From eight to twelve thousand suckers or slips are required to plant an acre.

Suckers and slips are removed from the parent plant after they reach full maturity, which is indicated by the brown color of the stem of the sucker or slip. In collecting these, laborers proceed through the fields, break them off and throw them into the aisles, to be collected into piles. The material is then trimmed (fig. 12) by cutting off the hard basal end and stripping off the lower leaves, a process which sometimes facilitates its rooting when planted in dry soils. Some growers cure their suckers and slips by exposing them to the sun for a week or two before planting, but while this process is supposed to make the plants more disease resistant, there is little evidence to show that any benefit is derived thereby.

FIG. 10.—A tempting slice of an Abachi (*Abakka*) pineapple.

Planting may be done at any time within two or three weeks after the suckers or slips are gathered. Slips are usually set 2 to 4 inches deep and suckers from 3 to 5 inches deep, according to size. In setting (fig. 13), a small hole is made in the soil with the fingers or with a dibble, a slip is inserted, and the soil then firmed about it so that the bud is about 1 inch above the surface of the ground.

SELECTION OF SUCKERS AND SLIPS.

In gathering suckers or slips for planting, few growers pay any attention to the quality or condition of the parent plant or to the

FIG. 11.—A pineapple of the Abachi (*Abakka*) variety, showing basal slips, crown slips, and crown.

desirability of the fruit which it bears. All suckers and slips of convenient size for planting usually are collected, and when they are scarce even the smallest and scrubbiest, including those from weak

or diseased plants or from plants bearing small, misshapen fruits, are gathered and planted. As a result of this indiscriminate planting, many undesirable types of plants and fruits are perpetuated. Moreover, it is probable that communicable diseases are frequently transmitted from unhealthy parent plants to new fields.

Trial plantings made by the Bureau of Plant Industry of the United States Department of Agriculture and investigations made throughout the Florida pineapple sections have shown emphatically that more care in selecting propagating material is essential. It has been found that large slips and suckers selected from healthy, vigorous plants not only produce much stronger plants but they are more free from disease. Furthermore, they come into bearing from

FIG. 12.—Trimming pineapple suckers and slips.

12 to 24 months sooner than weak or diseased plants (figs. 14, 15, 16, and 17). Suckers and slips selected from poor plants start to grow very slowly and rarely become strong plants or produce profitable crops (fig. 14). In every case observed the best results were obtained where material was selected with the greatest care from the strongest, healthiest, and most productive parent plants. The reputed superiority of Cuban grown slips is due solely to the fact that they are larger and have usually been taken from strong, vigorous plants. Home-grown slips give similar results when selected from equally desirable plants.

In order to insure the selection of suckers and slips from the best plants, the finest and healthiest parent plants should be marked at fruiting time, when their inherent characteristics are most apparent. They may be marked by means of stakes, by splashing a little white-

wash on one or two of the most prominent leaves, or by other convenient methods. When the propagating materials are collected, the plantation owner should make sure by careful supervision that only these selected materials are taken. When parent plants have not been marked at fruiting time or when an insufficient number have been so marked, special care should be taken to see that slips are collected from the healthiest and most vigorous plants in the field.

There is no longer any doubt that the proper selection of the best parent plants, long recognized as most important with other crops, is just as essential to the best results in pineapple growing. By careful selection of suckers and slips the size and quality of pineapples can be greatly improved. Many of the failures in the past

FIG. 13.—Setting pineapple plants. Strong, healthy slips are being planted.

have been due in large measure to the careless selection of slips, especially to the use of slips from weak or undersized plants.

MANAGEMENT OF PINEAPPLE PLANTATIONS.

CLEARING AND MARKING OFF THE FIELD.

When virgin land is to be planted the timber growth usually is grubbed off, although pine stumps, which quickly decay, are sometimes left in place. After grubbing, the brush and roots are burned (fig. 18); however, this should not be done on the land to be planted, as fire destroys much of the valuable humus of the soil. After the land has been deeply plowed and leveled it is ready for marking off.

SPACING DISTANCE.

The fields are laid off for planting with a plow or a marker similar to that used in planting corn. In the commonly used wide-bed system, plants are usually spaced 22 inches apart in rows which are also 22 inches apart. Six rows constitute a bed, and every seventh row is skipped and left as an aïsle between two beds. Two rows are omitted after every third bed for a roadway. Approximately 10,000 slips are required to plant 1 acre with this spacing.

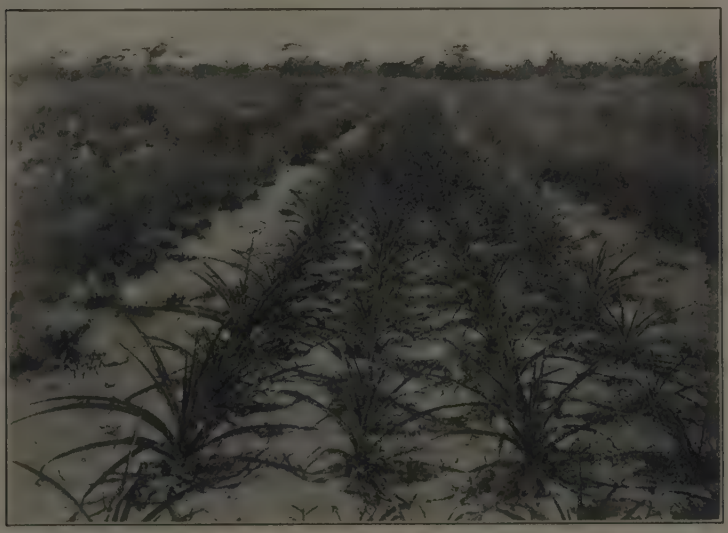

FIG. 14.—A 1917 planting of pineapple slips that were undersized in land that had not been improved, photographed in May, 1921. There are several patches of red wilt, but the plat is not seriously affected as a whole. Only 14 per cent of the plants are fruiting. Poor slips in unimproved soil mean failure.

In the Cuban planting system (fig. 19) occasionally followed, plants are set 10 inches apart in double rows, which are 12 inches apart, with 6 feet separating the pairs of rows. This system saves hand labor by permitting cultivation with horse-drawn implements during the first two years after planting; further, the fruit produced averages somewhat larger than where the wide-bed system is used. The losses from sunburned fruit are much greater, however, as the plants shade each other less than in the wide-bed system. The depletion of humus due to exposure to the sun is another disadvantage of the Cuban system.

GENERAL CULTURAL METHODS.

A few days after planting, a tablespoonful of cottonseed meal is dropped into the bud of the slip. This practice, known as "budding," results in the formation of a hard core, which prevents sand from blowing in and smothering the bud.

The general care of the pineapple field is comparatively simple, consisting mainly of three or four annual cultivations with the scuffle hoe to keep down the weeds. Care should be taken during the hoeing and other cultural operations to avoid breaking the brittle pine-

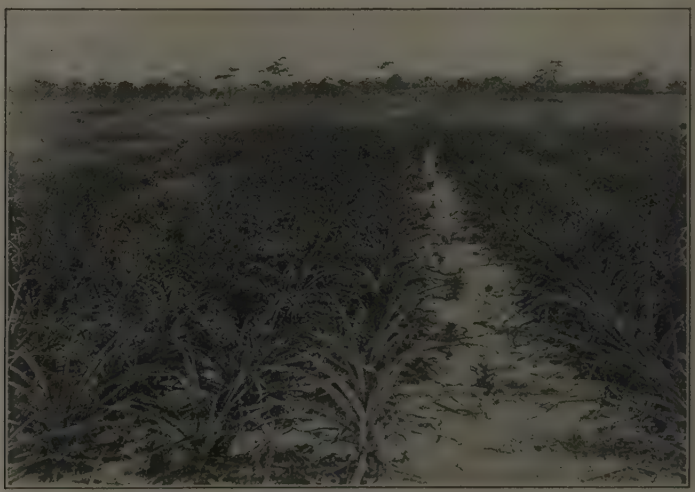

FIG. 15.—A 1918 planting of pineapple slips that were better than those used in 1917, but still below the standard, photographed in May, 1921. One year's growth of Natal grass was turned under. The plat is practically free from red wilt, and 31 per cent of the plants are fruiting.

apple leaves, as when these are injured they lose moisture to such an extent that the plant may be seriously damaged.

FERTILIZATION.

Most Florida pineapple soils are very low in fertility and require heavy applications of fertilizers as well as the addition of humus for the production of profitable crops. Many systems of fertilization are used successfully. The Florida Agricultural Experiment Station recommends for the average soils of the east-coast pineapple belt from 3,500 to 4,000 pounds to the acre annually of commercial fertilizer analyzing 5 per cent nitrogen, 4 per cent available phos-

phoric acid, and 10 per cent potash, applied in four applications a year for the first 18 months after the field is planted.[4]

It is further recommended that after this a similar yearly amount be given in two applications, namely, in February, and in July after harvest. Nitrate of soda may be used during the first six months after planting, but after that time organic forms of nitrogen, such as tankage, cottonseed meal, and dried blood give the best results. Finely ground steamed bone is recommended as preferable to acid phosphate as a source of phosphorus and sulphate of potash as preferable to muriate of potash.

The fertilizing methods used by successful growers vary greatly and there is very little agreement as to what constitutes the best prac-

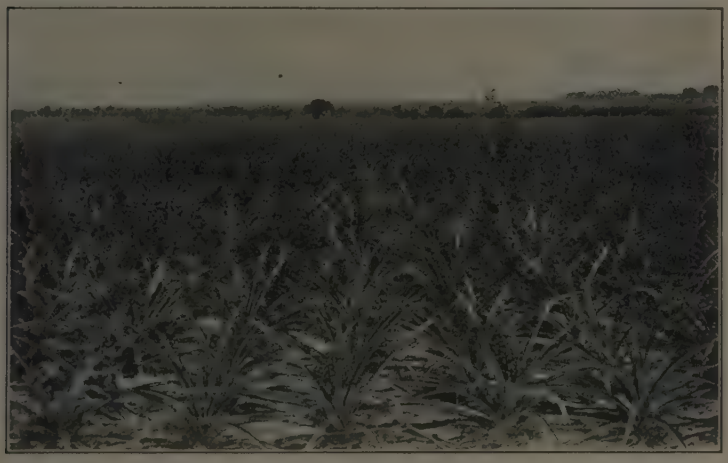

FIG. 16.—A 1919 planting of pineapple slips that were somewhat above the average in size and vigor, photographed in May, 1921. A growth of Natal grass for two years was turned under. There are no signs of red wilt, and 74 per cent of the plants are fruiting.

tice. A number of successful growers apply a ton of tankage to the acre in July after the main crop is harvested and add a light dressing of tobacco stems in the fall or in early spring. Other leading growers have obtained excellent results from an application of about 1,500 pounds of standard commercial "pineapple fertilizer" in February, followed by a second similar application after harvest and a third application of 1,000 to 1,200 pounds of tobacco stems in early winter. A beginner in pineapple growing should follow the methods found most successful by experienced growers in his immediate vicinity. At the same time he should carefully experiment

[4] Miller, H. K., and Blair, A. W. Pineapple culture. III. Fertilizer experiments. Fla. Agr. Exp. Sta. Bul. 83, p. 436. 1906.

with different combinations of fertilizers, in order to determine the best method of fertilizing for his own particular conditions.

SHED CULTURE.

For growing pineapples in sections too cold for culture in open fields and also where the protection of fancy tender varieties is desired, protecting sheds are often used. All of the plants in the vicinity of Punta Gorda (see fig. 1, *C*), where the choice, tender Cayenne variety is grown, as well as most of the few plantings in the central counties (fig. 1 *D*) are provided with shed protection. In addition to furnishing to the plants marked protection from the

FIG. 17.—A 1920 planting of pineapple slips somewhat below standard, photographed in May, 1921. A growth of Natal grass for three years was turned under. In a few months they will equal in size the 1917 plantings of poor slips in poor soil and will probably produce a good crop in 1922. Natal grass sod is shown at the left and a 1919 planting of pineapples in the background.

cold, these sheds prevent excessive evaporation from the soil and the foliage of the plants, thus conserving the moisture. When grown under sheds the plants are usually more vigorous and productive and the fruit is larger, better in dessert and shipping quality, and freer from sunburn than if the plants were grown in the open (fig. 20). For these reasons sheds are sometimes used in regions comparatively free from frosts.

The methods of constructing sheds vary with the material available. The sheds are usually made 6 to 7 feet high to allow perfect freedom in working under them. A plan of construction frequently used is to set pine posts firmly in the ground about 9 by 14 feet apart, with stringers of 1 by 8 inch material attached to the top of these

posts running the 14-foot way. A narrower strip placed below the main stringers is nailed to the posts, running the 9-foot way, to give additional firmness. The roof is made of common building lath or of 1 by 3 inch pine boards 18 feet long nailed to the stringers, leaving a 3-inch space between boards. It is a generally recognized principle that regardless of other details of construction the best results are obtained when about one-half shade is provided.

In the colder localities of Florida where pineapples are grown sheds are usually provided with side walls of cloth or boards, used for additional protection during severe freezes.

The cost of construction of pineapple sheds in 1918 averaged in the neighborhood of $800 an acre, and the annual expense for upkeep was about $75. While plants grown under sheds are more vigorous than those grown in the open, they are not free from disease, and in

FIG. 18.—Clearing land for pineapples.

view of the increasing difficulty in securing profitable yields under any condition few growers feel justified in making the large investment required for shed construction and upkeep. The use of sheds in the future will probably be largely confined to the production of fancy, high-priced varieties, which are most likely to repay the extra investment and care involved.

HARVESTING AND MARKETING.

Although some fruits ripen and are shipped at all seasons of the year the main harvest season for Florida pineapples extends from late May to mid-July. In harvesting, laborers protected from the sharp spines of the plants by heavy canvas gloves and leggins proceed through the fields, break the fruits from the plants, and toss them to other laborers stationed in the aisles between the beds (fig. 21), who

carefully catch the fruits and deposit them in the field crates. The fruit is then hauled to the packing house by wheelbarrow, wagon, or motor truck (figs. 22, 23, 24, and 25), where it is in turn sized, graded, wrapped in tissue paper, and packed in crates holding 18 to 56 pineapples (figs. 26 and 27), depending upon the size of the fruit. The unique methods of harvesting and gathering pineapples and the great activity during the height of the shipping season furnish a most interesting and picturesque spectacle.

NECESSITY FOR MORE CAREFUL HANDLING OF THE FRUIT.

Investigations of the Bureau of Plant Industry of the United States Department of Agriculture conducted in Florida and other

FIG. 19.—Pineapples planted by the Cuban or double row method. This system permits cultivation by horses, but increases the loss from sunburn.

investigations made in the West Indies[5] have demonstrated that greater care should be used in all the operations of harvesting, packing, and shipping the fruit, in order to prevent punctures and bruises, which are the chief sources of decay. It has been shown that fruit should be shipped as promptly as possible after picking, as its keeping quality is greatly impaired by delay either in the field or packing house, especially when the weather is warm; also that fruit should be packed only when it is dry, as decay is greatly favored by the presence of moisture. Neglect to handle the fruit carefully and ship it promptly often results in very heavy losses, the pine-

[5] Mann, C. W. The handling of Porto Rican oranges, grapefruit, and pineapples. Porto Rico Insular Exp. Sta. Bul. 7, 59 p., 24 fig. (on 18 pl.). 1914.

apples arriving at the northern markets in an almost unsalable condition on account of extreme decay.

PLANT-RIPENED PINEAPPLES.

For shipping to distant markets, pineapples are usually picked and packed while still hard and green. While this green fruit becomes yellow and edible before it reaches the consumer, it is never equal in sweetness or flavor to fruit which has been permitted to ripen on the plant. The reputation made by the canned pineapples imported from Hawaii is largely due to the fact that this fruit is picked only when fully matured.

FIG. 20.—Vigorous pineapple plants growing with shed protection.

Experiments of the Bureau of Plant Industry of the United States Department of Agriculture have shown that the superior plant-ripened fruit, if picked at the proper stage of maturity, carefully handled, and promptly shipped in iced cars, may be sent to northern markets with very little decay.

The best stage of maturity for picking plant-ripened fruit was found to be the hard-ripe, or "ruddy-ripe," stage, when the pineapple has turned to a reddish yellow but before it becomes fully yellow or soft. At this stage of maturity the fruit has reached the acme of dessert quality but is still firm enough to permit shipping for long distances if properly handled.

This method of shipping plant-ripened fruit has many possibilities and is considered of special promise for growers who raise the choice varieties for the fancy-market trade.

When green fruit is shipped in the ordinary way and allowed to ripen en route to market, only fully grown pineapples with well-developed eyes having a trace of light green showing between them should be picked. Purplish green fruit and fruit with partially developed or shrunken eyes should be left on the plants until they have reached the condition described above.

Immature fruit is low in table quality and ships and keeps poorly. Overripe, soft, or defective fruit should be excluded from the general pack and canned, sold on the local market, or otherwise used. The

FIG. 21.—Picking pineapples. The "pines" are broken from the plant and thrown to laborers in the aisles, who catch them and deposit them in field crates.

question of proper maturity for picking as well as the factors involved in the careful handling of fruit to prevent decay demands closer attention from pineapple growers than has usually been given. Further information relative to methods of shipping and handling pineapples may be obtained by addressing the United States Department of Agriculture.

YIELDS AND PROFITS.

When vigorous, healthy, carefully selected slips have been planted under favorable conditions, the first crop of pineapples is harvested about 20 months after planting, and annual crops are secured thereafter during the life of the plantation. Yields vary greatly, de-

pending upon the skill of the grower, the season, and other factors. A yield of 200 crates to the acre was formerly considered a good average, although some growers secured 300 crates or more. Prices have fluctuated greatly, but in average seasons have been quite satisfactory, and frequently additional receipts are obtained from the sale of slips. Taken as a whole, the pineapple industry up to about 1917 was profitable and yielded satisfactory returns (fig. 28). At the present time (1920) prices for pineapples are higher than ever before, but, for the reasons mentioned, production and profits in most fields have reached the vanishing point.

FIG. 22.—Collecting pineapple fruit for hauling to the packing house.

BEARING LIFE OF PLANTATIONS.

The period during which pineapple fields bear profitable crops varies with the site, soil, care, and other factors.

Plantings made in the earlier days of the industry on virgin soil, comparatively free from disease, occasionally bore profitably for 10 years or even longer, although in most cases production declined so rapidly after the fifth year that further maintenance was unprofitable. In more recent years the depletion of soil humus and the increasing prevalence of disease have greatly shortened the productive life of plantations. Most fields set out since 1915 were abandoned after the second or third year and many were given up before a single paying crop was secured. The condition of the industry has grown steadily worse, and the severe freeze of February, 1917, so greatly damaged the already weak and diseased plants that most of

the fields have been abandoned altogether. Many attempts have been made to clear and replant these abandoned fields, but while replanting was often successfully accomplished in the earlier years of the industry, most of the attempts in recent years have been complete failures. Many reasons have been advanced to explain the decline of the industry, including inferior fertilizers, particularly unfavorable seasons of weather, high freight rates, labor costs, and other causes. The chief reasons, however, are now determined to be the depletion of soil humus, the prevalence of wilt, and the scarcity of desirable slips.

In replanting, old plants are usually grubbed out and burned. A number of growers have spaded them into the ground at considerable cost, with the idea of adding humus to the soil. However, new plant-

FIG. 23.—Pineapples piled in field crates ready for hauling to the packing house.

ings made where the old diseased ones have been spaded in, though starting to grow vigorously, have in nearly every case died out on account of wilt after the first or second year. The practice of spading under the old plants and resetting immediately does not seem, therefore, to be advisable. Better results have been obtained by plowing rotted leaves and litter from woodlands into the soil. The most desirable measures to be taken before replanting are those described in connection with the discussion on the restoration of the pineapple industry.

PESTS AND DISEASES.

PESTS.

Among the several pests found in Florida pineapple fields are the red spider, which attacks the basal part of the leaves, and the mealy

bug, which feeds on the buds and the leaves. Both of these pests are common, but they seldom inflict severe damage. Usually their attacks can be diminished by dropping a handful of tobacco dust into the bud of the plant.

DISEASES.

The soft, dark, fermented, decayed condition of the fruit, frequently associated with heavy loss in pineapple shipments and commonly called soft-rot, is caused by the attacks of a fungus (*Thielaviopsis paradoxa*), which enters the fruit through bruises, punctures, and through the cut stem end. While decay due to this fungus is seldom great in the fields, it is sometimes so severe among pineapples in transit to market as to cause almost a total loss of the ship-

FIG. 24.—A track laid in light sandy soil to facilitate hauling by a motor truck. This view shows the topography of the east-coast pineapple region near Fort Pierce, Fla.

ment. This loss is particularly liable to occur in warm, humid weather, especially when the fruit has been roughly handled, packed while wet, or delayed before shipment,[6] the decay spreading rapidly from one affected fruit to other fruits in the same package. Pineapples that have been packed when mature, carefully handled, graded, and properly shipped are seldom seriously affected.

"Spike" or "long-leaf," a condition characterized by long, spindling or spiky leaves, most frequently occurs among pineapples grown on shell lands or other soils high in carbonate of lime, and these soils should be avoided in selecting a site for a plantation. There is some evidence that in a number of cases heavy applications

[6] Higgins, J. E. The pineapple in Hawaii. Hawaii Agr. Exp. Sta. Press Bul. 36, 34 p., 15 fig. 1912.

of commercial fertilizers, particularly muriate of potash, inorganic forms of nitrogen (commonly referred to in terms of ammonia), and acid phosphate have been followed by the appearance of "spike."

RED WILT.

The most widespread and destructive disease of pineapples in Florida is red wilt, also called wilt, or blight. It has been a chief cause of the decline of the industry in that State.

Plants affected with wilt gradually lose their normal healthy green color and assume a dull reddish hue. Usually the lower leaves are first affected, but the entire plant eventually becomes red and limp and finally droops and dies. The disease commonly appears first in a few individual plants or groups of plants scattered here and there about the field, but it gradually spreads through the entire

FIG. 25.—A motor truck loaded with pineapples on the way to the packing house.

planting (figs. 29 and 30). The affected plants sometimes survive the attacks for months, especially when the weather and other growing conditions are favorable, but in most cases they die rapidly after the first symptoms of disease appear. The roots are found to be rotted to a considerable extent, even in early stages of the disease.

THE RELATION OF RED WILT TO NEMATODES.

Although many theories have been advanced in explanation of the causes of red wilt, recent investigations[7] indicate that it is a diseased condition of the plant due, at least in large measure, to the attacks of nematodes (*Heterodera radicicola*), minute parasitic ground worms which infest most of the light soils of the South and

[7] Sherbakoff, C. D. Pineapple wilt. *In* Fla. Agr. Exp. Sta. Rpt., p. 93R–98R, fig. 15–16. 1917.

which are present in countless numbers in most of the Florida pineapple fields. These nematodes attack the pineapple plant by penetrating and destroying its fine feeding roots, thus gradually depriving the plant of its means of taking up food and water until, when all the feeding roots are killed, the plant dies. The root galls caused by the initiation of the nematodes are less conspicuous on pineapples than on other hosts of this pest, and the infested roots have a tendency to decay rapidly. A plant infested with nematodes has much the same appearance as if it were suffering from drought or lack of fertilizer, and this fact has resulted in much of the confusion regarding the real cause of the trouble (fig. 29). The wilting

FIG. 28.—A packing-house scene.

of pineapples in ways more or less similar to those characteristic of the Florida red wilt has been described from various parts of the world. It is possible that some of the diseases so described may have the same cause as the Florida red wilt.

Nematodes are readily carried from infested land to new soils on the feet of men or animals, on tillage implements, and in many other ways. Red wilt is usually first seen among pineapple plants adjacent to roadways, where they would be most liable to infestation in this way. Moreover, when pineapples are planted on cleared land adjacent to diseased fields the wilt first appears on those plants which are nearest to the old infested area. Slips from fields infested with wilt may possibly carry nematodes to new fields by coming in contact with infested soils. Many native weeds are hosts

for the nematode, and virgin land is not always entirely free from the pest. The infestation in abandoned fields is maintained on many of the weeds springing up naturally. The spread of wilt is often very rapid, pineapple plants on new fields usually showing symptoms within a year or two after the land has been planted. The spread often follows natural drainage slopes by the washing of infested soil.

CONTROL OF RED WILT.

Many methods of combating red wilt have been tried, but these have been generally unsuccessful, owing to the lack of understanding of the real nature of the disease. Slips have been brought from Cuba and other distant points in the expectation that they would

FIG. 27.—Packed crates of pineapples ready for shipment.

prove free from disease. There is no evidence to show that the imported slips are in any way more desirable than equally healthy, vigorous, home-grown slips. Besides, there is always the chance of introducing some unsuspected pest on plant material from outside sources. While the planting of good slips is of the utmost importance, not even the best of them can be expected to survive on soil depleted of fertility or infected with disease.

Another control measure which has been tried is that of spading calcium cyanamid into the soil at the rate of 1 ton or more to the acre.[8] The method has given some measure of success, but it is too expensive for general application.

[8] Watson, J. R. Control of root-knot by calcium cyanamid and other means. Fla. Agr. Exp. Sta. Bul. 136, pp. 145–160, fig. 67. 1917.

All varieties of pineapples grown in Florida are attacked by the nematodes. The Spanish is less susceptible, however, than the Cayenne. Investigations made by the Bureau of Plant Industry of the United States Department of Agriculture with the object of selecting resistant strains or varieties may eventually prove successful, but at the present time the only promising plan of controlling wilt is that of first freeing the soil of nematodes, as discussed under the heading "Restoration of the pineapple industry."

DEPLETION OF SOIL HUMUS.

Red wilt due to the attack of nematodes is closely associated with an equally important cause of the decline of the pineapple industry,

FIG. 28.—A productive pineapple field.

namely, the depletion of the humus or decaying vegetable matter in the soil. The destruction of humus through constant cultivation and the exposure of the light sandy soil to the tropical sun proceeds at a very rapid rate. Even in their virgin state Florida pineapple soils are poor in humus, and after a few years of intensive cultivation this scanty supply is almost exhausted, and the soil is left in an unproductive state, low in fertility, and lacking in soil organisms essential to healthy plant life. In such impoverished soils pineapples can not be expected to grow satisfactorily, even if no disease is present to further impair the vitality of the plants.

Pineapple culture on the keys and in other Florida sections was abandoned when the vegetable matter of the soils of the region became exhausted, and fields which have been long under cultivation or exposed to the sun for any length of time can seldom be successfully replanted. It is clear, therefore, that in restoring abandoned pineapple fields the replenishment of the diminished humus supply must be given full consideration.

RESTORATION OF THE PINEAPPLE INDUSTRY.

The chief problem which must be solved before pineapples can be replanted in Florida is the reduction of the number of nematodes and the restoration of the depleted soil humus. Fortunately, the

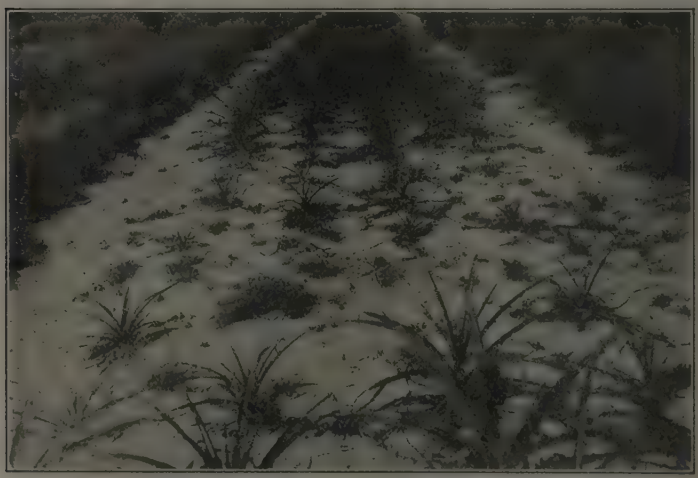

FIG. 29.—A typical spot in a field infected with red wilt. Photographed May, 1921, in the 1917 planting of pineapples shown in figure 14.

remedial measures most promising in controlling nematodes are also most successful for replenishing soil fertility and humus.

A number of the crops, particularly Natal grass, velvet beans, and the Iron or other nematode-resistant varieties of cowpeas, which can be grown even in the light soils of the old pineapple fields, are nearly or quite immune from attacks by nematodes. By growing these crops for a period of several years the pests can be starved out, and at the same time the fertility of the soil can be built up to a degree favorable to the growth of pineapples. Preliminary results from experimental plantings made by investigators of the Bureau of Plant Industry [9] have shown that of these crops Natal grass (*Trich-*

[9] Fulton, H. R., and Winston, J. R. Prevention of root-knot in pineapples. *In* Fla. Grower, v. 20, no. 17, p. 7, illus. 1919.

olaena rosea Nees)[10] makes by far the quickest and heaviest growth, and of all crops tried it is the most satisfactory and cheapest to plant. After land had been sown and allowed to remain in Natal grass for two years or more it was found that the nematodes had practically disappeared and that, moreover, the soil had become darker in color and rich in humus and fertility. Healthy, vigorous slips recently planted on this restored land have given every promise of high future production. (Figs. 16 and 17.) Plants growing vigorously under such favorable soil conditions suffer less from cold injury than less vigorous plants. They are able readily to replace roots that may be destroyed by nematodes and so can withstand moderate attacks of this pest.

FIG. 30.—Pineapple plants on hammock soil rapidly succumbing to wilt.

A PRACTICAL METHOD OF RESTORING ABANDONED PLANTATIONS.

In conformity with the results thus far obtained in these experimental plantings, it is suggested that owners of land formerly planted to pineapples who desire to put it in good shape for replanting proceed in the following manner: The old plants that remain should be first gathered and then removed or left to rot on the land. Natal grass seed should be sown broadcast at the rate of 8 or 10 pounds per acre. This can be done at any time of the year when

[10] Fulton, H. R., and Winston, J. H. [J. R.]. Natal grass and the control of pineapple root-knot. *In* Fla. Grower, v. 22, no. 16, p. 22. 1920.

Tracy, S. M. Natal grass, a southern perennial hay crop. U. S. Dept. Agr. Farmers' Bul. 726, 16 p., 4 fig. 1916.

the soil moisture is sufficient for germination, but preferably in the fall. Under ordinary conditions this grass will quickly make a good start and should be left undisturbed and allowed to reseed itself at will (fig. 31). It will probably be effective to allow the land to remain in Natal grass for two years, but if the soil is in a very impoverished condition or badly infested with nematodes, three years or longer may be necessary.

Before the Natal grass is turned under, tests should be made to determine whether or not the nematodes have been starved out. A few pepper plants may be set in spots here and there through the field. If these grow vigorously, with roots free from the nematode galls, it may be assumed that the nematodes are practically eliminated, because peppers are very susceptible to attack by this pest and

FIG. 31.—A field in Natal grass at the left. At the right is a field in which Natal grass has recently been plowed under and pineapples set out.

would be affected where nematodes are abundant. After tests made in this way indicate that the nematodes have been sufficiently reduced or eliminated, the Natal grass can be plowed under and pineapples replanted.

In replanting, the most vigorous and healthy slips should be selected. The fields should then be given good care and every effort made to increase the vigor and consequently the disease resistance of the plants and to reduce the chances of nematode infestation from near-by infected fields. The soil, however, is likely to become reinfested sooner or later, often by the time three or four crops have been harvested. When the replanted fields begin to show decreased yields as a result of reinfestation, the land should be resown with Natal grass seed and that grass grown until the humus is restored and the

nematodes starved out. In following this plan of restoration it will be necessary for the pineapple grower to have one-third to one-half of his acreage in Natal grass. The added fertility secured in plowing under the Natal grass should fully cover the expense involved in carrying out the plan of rotation.

Many other methods of restoring pineapple fields have been attempted, but without success. It seems certain that no plan which neglects either nematode control or humus restoration can be successful. On the other hand, a number of growers who have put into practice the plan suggested above are now securing promising results and are producing crops on a profitable basis. The building up of abandoned pineapple soil with Natal grass in the manner suggested promises to be a slow but sure method of reviving the pineapple industry not only in Florida, but in other sections where similar conditions exist.

CONCLUSIONS.

A small portion of the abandoned pineapple land, particularly that of the hammock type, is richer than the average in fertility and is well suited for the culture of vegetables and fruits, such as limes, grapefruit, and avocados. Many growers who formerly raised pineapples exclusively are planting these richer soils to some of these crops. Diversification of this sort is safer and in the end probably more profitable than specialization with a single crop, and it should be encouraged. However, as the acreage of land suitable for these other crops is limited, the future prosperity of the farmers of the pineapple section depends largely upon the restoration of the pineapple industry.

Persons contemplating going into pineapple growing should thoroughly investigate conditions at first hand before making any investment. This precaution should be taken not only by prospective pineapple growers, but also by anyone planning to grow fruit crops in Florida or any other part of the country. The rewards of fruit growing are often excellent, but success requires careful preliminary investigation, considerable skill, and hard work, particularly where the capital is limited. Pineapple growing is no exception to the rule. The new grower in Florida should consult with the agricultural investigators of the State and Federal Governments, and especially with successful and established growers. These men are familiar with the ups and downs of pineapple growing, and it is due to their determined efforts for the restoration of the industry that the future of pineapple growing now appears encouraging provided proper restoration methods are adopted.

HOW TO DO IT.

Do you want practical suggestions on how to build a silo, a hog house, a poultry house, a potato-storage house, or how to make a fireless cooker, or other farm convenience? Are you seeking ideas on how to prepare vegetables for the table, how to care for food in the home, how to bake bread and cake and other appetizing foods in an efficient and economical manner? Is there some practical question about your corn or wheat or cotton or other crops, or about your poultry or live stock, to which you are seeking an answer? The answers to thousands of such questions and practical suggestions for doing thousands of things about the farm and home are contained in over 500 Farmers' Bulletins, which can be obtained upon application to the Division of Publications, United States Department of Agriculture, Washington, D. C.